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STATE OF MONTANA

DEPARTMENT OF STATE LANDS

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LEO BERRY, JR
COMMISSIONER

MINING

RECLAMATION

TO WHOM IT MAY CONCERN:

The following guidelines were derived to answer operator's requests to the Department of State Lands for more specific information concerning necessary techniques and methods which should be used to meet the requirements for data collection under "The Montana Strip and Underground Mine Reclamation Act", Title 50, Chapter 10, R.C.M. 1947.

The guidelines were written up after consultation with interested parties. Further consultation concerning techniques and methods prescribed are welcomed.

Guidelines are not law but do represent the department's interpretation of the law and the techniques and methods which should provide the information required by law. There may be other acceptable techniques or methods which will also provide information required under the law and the department will consider any scientifically correct study design.

All facets of the guidelines should be discussed between departmental staff and operator consultants or employees to assure understanding of the programs before any preplanning work is initiated on the ground.

Sincerely,

Richard L. Juntunen

Richard L. Juntunen, Chief
Coal and Uranium Bureau
Reclamation Division

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Reclamation Division
Department of State Lands
Helena, Montana 59601

STRIP MINING AND RECLAMATION ACT

Reclamation Plan

The plan should be drafted using the statute and rules and regulations as guidelines. A positive commitment to each item or category in the statute or rules should be made with appropriate explanations, narratives, diagrams, etc. to explain or discuss how information was obtained and how certain commitments will be met.

Mining Plan

The mining plan should be developed with all reclamation requirements in mind. A mining plan that does not meet all reclamation requirements will not be accepted.

Preplanning Inventories

These shall be submitted for the proposed life of the operation unless otherwise approved by the Department.

Complete Applications

Applications should be complete when submitted. Preplanning inventories, surveys, maps, reclamation and operating plans, etc. should be complete and included with the application.

Mine personnel, consultants, contractors, etc. must be made aware of the conditions of the permits. Problems have become evident because there has been a lack of communication between the people who prepare an application and those people who conduct the operation or are responsible for field performance.

Bonding - Permit Maps

Bonds and types of disturbances will be based on three general bonding and permitting levels as follows:

1. Mining level: This category includes the pit, spoils, topsoil salvage area, ramp roads, etc.

2. Facilities: This category includes those structures, roads, railroad loops or spurs, settlings or treatment facilities, loadout and storage facilities, etc. that are more or less permanent through the life of the mine.

All maps should be at a scale of 1" to 400' though other scales may be approved. Maps for any permit should be on a single sheet format. Color coding is acceptable though a system of differing hash marks may be preferable if a microfilm system of filing is developed, as color codes do not microfilm.

All maps should show section corners, township and range based on the Montana principal meridian.

Mapping requirements

The following maps should be included for a complete application.

1) A most recent photo enlargement at the same scale as overlays and other maps, depicting the mining operation, is required on a yearly basis. All amendments or permits during any one permitting year could reference the proper photo enlargement.

2) A permit map which should show the various bonded levels as well as information required on page 8, subsection (3), (a) (b) (c) (d) (e) (g) (h) and (l). The acreage of the various areas shown on the permit map must be clearly shown.

3) A soils map which should be an enlarged aerial photograph at the same scale as other maps.

4) A vegetation map which should be an overlay over the soils map. Information required on page 8, subsection (3)(k).

5) A premining topography map should be submitted with at least a 10' contour interval and information on page 8 subsection (3)(j) should also be shown.

A proposed post mining contour map with 10' contour interval should be submitted with accurate information concerning the final contour of the reclaimed area.

6) If a separate wildlife habitat map is submitted then this map should be an overlay over the soils map.

7) A mining plan map or overlay showing the sequence of various mining cuts and projected mining progress. Information on page 8 subsection (3),(i) in the law.

8) A life of the operation map or overlay showing estimated life of the operation with mining sequence and projected mining progress over the life of the operation is required though this map may require a smaller scale to cover the total area.

9) Maps of groundwater hydrology and surface hydrology should be submitted. The hydrology guidelines give the details for these maps.

10) Archaeology mapping requirements are found in the archaeology section.

3. Associated disturbance: This category includes those areas in advance of mining used for miscellaneous minor disturbances such as power lines to equipment, portable substations, topsoil stockpiles, diversion ditches, small detention or diversion dams and impoundments, etc.

Bonds should be calculated on an actual reclamation cost to the company basis. The attached format or a similar one devised by the company should be used in determining reclamation costs and submitted as part of the application. Average costs should be calculated for the three disturbance categories above. The Department of State Lands will multiply the proposed bonding level by a 10% escalator to cover costs of the state to perform the reclamation.

RECLAMATION COST ANALYSIS
(Sample)

The following is an analysis of the cost of reclaiming the various disturbances associated with strip mining. It is furnished to the Department of State Lands in order to facilitate establishment of proper bonding levels. All costs and prices are based on current contractors' estimates to perform the reclamation work in accordance with Chapter 10, Title 50, R.C.M. 1947 and the proposed reclamation plan.

1. Highwall reduction and backfilling

   A. Drilling and blasting
   _____ holes at $_____/hole = _____

   B. Earth moving work
   Highwall reduced using D9 dozers
   _____ cu. yds. at $_____/yard = _____

   C. Box Cut spoil haulage using D9 dozers
   _____ cu. yds. at $_____/yard = _____

   TOTAL HIGHWALL REDUCTION $_____

2. Spoil and Ramp Road Grading

   A. Ramp Road No. 1
   _____ cu. yds. at $_____/yard =

   B. Ramp Road No. 2
   _____ cu. yds. at $_____/yard =

   C. Ramp Road No. 3
   _____ cu. yds. at $_____/yard =

   D. Spoils
   _____ cu. yds. at $_____/yard =

   TOTAL $_____

3. Grading other associated disturbances

   Highwall Access Road
   Obliterated during highwall reduction

A. Haulageway Roads
_____ cu. yds. at $_____/yard = _____

B. Service Roads
_____ cu. yds. at $_____/yard = _____

C. Diversion Ditches
_____ cu. yds. at $_____/yard = _____

D. Shops, tipple, railroad loop, etc.
_____ cu. yds. at $_____/yard = _____

TOTAL $_____

4. Topsoil Redistribution

_____ cu. yds. at $_____/yard = _____

5. Site Preparation

Includes farming techniques to prepare area for planting

_____ acres at $_____/acre = _____

6. Revegetation

Average bid for seed, fertilizer and drilling

_____ acres at $_____/acre = _____

7. Facility Removal

A. Buildings, silos and plant equipment = _____

B. Railroad loop (No. of miles) = _____

TOTAL $_____

Breakdown of acreage involved in various categories of proposed permit area.

Description	Length	Width	Acre (fr^2)	Acres
Highwall Reduction				
Box Cut No. 1				
Box Cut No. 2 (part)				
Spoil from West end to Ramp No. 1				
Spoil from No. 1 to No. 2				
Spoil from No. 2 to No. 3				
Spoil from No. 3 to East end				
Ramp Road No. 1				
Ramp Road No. 2				
Ramp Road No. 3				
SUBTOTAL				
Haulage Road from No. 1				
Haulage Road from No. 2				
Haulage Road from No. 3				
Service Roads				
Diversion Ditches				
West Ditch				
North Ditch				
East Ditch				
SUBTOTAL				
Settling Pond				
Shop, tipple area				
Rai. .oad loop				
SUBTOTAL				
TOTAL				

Total estimated cost of reclamation $_____

$_____ (Total Cost) + _____ (No. of Acres) = $_____ Per Acre

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ENGINEERING GUIDELINES

Applicants for mining permit shall submit, in addition to the usual maps showing the area of excavation to be covered by the permit, a metes and bounds description of such area. Such description should be based on and include a survey tie to any convenient G.L.O. corner or monument, the location of which can be positively identified, which is outside the area of anticipated excavation during the life of the mine. If no such markers are available, a monument for use as an initial point should be constructed in a convenient location where it can remain undisturbed during the life of the operation, and the metes and bounds description tied to this initial point. The monument should be close to the mine area.

Among the advantages of such action it is anticipated:

1. The area boundaries will be exactly defined.
2. More exact computation of acreage will be possible.
3. Exact retracement of area at any time will be permitted even though mining and subsequent reclamation may have obliterated all pre-existing cultural, topographic and physical features.
4. In future years as reclamation has been completed on previously permitted areas, it will make it possible to accurately define the area for which discharge of the reclamation bond is being requested.

A corner post, stake, or other monument, is required to be placed upon the ground at each angle in the perimeter of the annual permit area (mining area) as defined by the metes and bounds description. The spoils boundary delineation will not be necessary except for previously unmined sites.

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GEOLOGY GUIDELINES

Compilation of geologic information should be done in conjunction with hydrologic investigations. Companies should draw up a tentative drilling program and make arrangements to discuss it with the Department beforehand. In general, cored drill holes are preferred but site stratigraphy may allow accurate cross-sections to be drawn from cuttings and geophysical logs. The Department will make a study of the known stratigraphy in the region under study and make a determination of the drilling procedure to be followed. Companies should expect that some coring will be required in order to provide a control. When cuttings are used, samples of the cuttings will have to be collected at five (5) to ten (10) foot intervals, and several methods of geophysical logging will be expected. The latter will normally consist of SP, point resistivity, and natural- or gamma-gamma logs.

Depending on local stratigraphy, geologic data to a depth of 400 feet may be required under the immediate area to be mined. This requirement will be waived if existing data makes it clear that stripping ratios or other factors render mining to that depth untenable. In all cases, however, drilling to at least 200 feet will be expected. Beyond the area to be mined, depths of drilling will be dictated by the needs of the ground-water hydrology study.

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COAL MAJOR ANALYSES

Coal analyses should be done when possible on cored samples rather than on cuttings in order to minimize contamination by drilling fluid. Analyses submitted with each annual application should be of areas to be mined rather than of areas which have already been mined. Air coring should be done whenever practicable.

Analyses should be peformed on all economic coal seams. In general composites should be taken on approximately each five feet (5') of core. As seam thicknesses vary from mine to mine, however, sampling procedures will also vary. Companies should accordingly contact the Department before sampling in order to establish a specific sampling program.

Below is a listing of parameters which comprise an acceptable coal analysis:

Proximate	Ultimate	Forms of Sulfur
Moisture	H	Sulfur
Volatile Matter	C	Sulfate
Fixed Carbon	N	Pyrite
Ash	O	Organic
	S	
	CL	

Equilibrium Moisture

Ash Fusibility	Heating Value
Initial Deformation Temperature	BTU Softening
Temperature Fluit Temperature	

Ash		
		Hardgrove Grindability Index
AL_2O_3	P_2O_5	Specific Gravity
CaO	S_1O_2	
Fe_2O_3	SO_3	
K_2O	T_1O_2	
MgO	Na_2O	

COAL TRACE ELEMENT ANALYSES

A minimally acceptable coal trace element analysis will comprise the following elements: Ag, Cu, Ni, Pb, Cd, Zn, Se, Mn, Cr, Hg, B, Be, As, Ge, V, Mo, U, F. Analyses of these elements should be done by methods accurate to ± 20 percent of actual concentration. Spark source mass spectrometry is recommended as the most comprehensive accurate method. Analyses done by the latter method should include all identifiable trace elements, although only those listed above need be done to ± 20 percent.

Other methods, such as neutron activation analysis may be applied. Analysis done by standard wet chemical methods should be done as follows:

Ag - atomic absorption spectrometry
Cu - atomic absorption spectrometry
Ni - atomic absorption spectrometry
Pb - atomic absorption spectrometry
Cd - atomic absorption spectrometry
Zn - atomic absorption spectrometry
Se - atomic absorption spectrometry
Mn - atomic absorption spectrometry
Cr - atomic absorption spectrometry
Hg - double gold amalgam flameless atomic absorption
B - emission spectrometry
Be - emission spectrometry
As - colorimetric
Ge - colorimetric
V - colorimetric
Mo - colorimetric
U - fluorometric
F - specific ion electrode

Trace element analyses should be done only on samples which have been analyzed for major constituents. Companies should contact the Department to determine which samples are to be analyzed for trace elements.

Standard solutions should be prepared from soluble salts. Use of rock standards, such as thos obtainable from the U.S.G.S., is not encouraged, but they may be used if individual element data are known to be accurate, e.g. bold-face values in Fleischer (GEOCHIMICA ET COSMOCHIMICA ACT A, 1972).

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ARCHAEOLOGY GUIDELINES

These guidelines should be considered as a basis around which an archaeological survey, on proposed coal mining areas, should be developed. They are intended to aid the applicant in designing a survey which will comply with state laws and describe sites of archaeological significance in such a manner as to aid in the decision making process.

A. Objectives of the survey

1. To obtain a listing, location, and description of the archaeological and historic resources of the area to be affected.

2. To evaluate the sites and describe measures which will mitigate the impacts of the operation.

3. To collect and preserve archaeological and historical resources of significance. These resources are to be maintained within the boundaries of the state.

4. To briefly describe, in a narrative form, the prehistoric and historic cultures which utilized the survey area.

5. To prepare a map depicting the location and extent of the resources.

B. Pre-survey study plan

Definitions of those aspects of the survey which require definition should be proposed prior to commencing the survey. These definitions are subject to change upon notification of the Department and approval of such changes. Such definitions will eliminate bias and aid in formulating hypotheses. Some of the definitions which will be required are:

1. What constitutes a site?

2. What is archaeologically significant?

3. Which sites are to be tested?

4. How will testing proceed in different depositional areas?

These definitions should be based on previous archaeological surveys in the area, literature reviews, and the expertise of the archaeologists doing the survey. Further, definitions should be based on sound, currently accepted, archaeological principles.

In addition to areas where surficial evidence indicates possible subsurficial deposits, all areas where no surficial artifacts are present but sub-surficial resources are expected will be tested to determine the vertical and horizontal extent of any resources.

On site inspection of topographic features should be used in determining the survey grid (travel routes). The survey grid should then be plotted on a topographic map to identify adequacy of coverage of the project area. Surveys will include all lands within the mining and associated disturbance areas and extend a minimum of one (1) mile in all directions from the proposed project boundaries. Special attention must be paid to those areas which are most likely to possess archaeological or historical resources.

An adequate amount of time, measured in man-days, will be allotted to the survey. No less than one man-day/120 acres will be spent on the extensive survey. Any additional time required for more intensive work will be in excess of this amount.

C. Interim report

An interim report should be prepared at the completion of the extensive survey. This report will be utilized to evaluate the progress of the survey. Such a report should include but not necessarily be limited to:

1. Definitions and hypotheses formulated during pre-survey planning.

2. A map or overlay depicting the survey grid proposed in the pre-survey plan.

3. A map or overlay showing locations of site resources (this map may be included on map in #2 above). This map should show locations of artifacts which are considered to be "isolated find spots".

4. A listing of legal description, type of site, and recommendations regarding the site.

5. A narrative description of the resources identified at each site and their implications as to the cultural period the site was utilized and the purposes for which the site was used.

D. Final report

A final report will be prepared and submitted to the department. This report will be the basis for the decision making process. A final report will include the following:

1. All information included in an interim report.

2. A log of all test pits and core drillings conducted (a log will include location, depth of test and depth at which resources were recovered).

3. A narrative description of the mitigating measures which can feasibly be instrumented.

4. A brief narrative outlining the pre-historic and historic use of the area in question.

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AIR QUALITY GUIDELINES

All monitoring or air quality assessment will involve cooperation between the Department and the Air Quality Bureau of the Department of Health and Environmental Sciences. AQB has responsibility to protect Montana's air quality, both with respect to Federal and State standards or regulations.

Coal mining activities within Montana must (1) comply with state[a] and federal air quality standards[b]; (2) prevent air quality deterioration[c] in "clean" areas of Montana; and (3) set up strategies for the attainment and maintenance[d] of air quality in areas where standards are exceeded or projections show violations prior to 1985.

It is necessary for the Air Quality Bureau and DSL to follow mining activities via air monitoring information. Such information will assist the AQB and DSL in their commitment to maintain air quality standards and to evaluate mining operations.

I. MONITORING

Coal mining companies will be expected to collect at least one-year (four quarters) of background information prior to any disturbance. With the commencement of mining activities and/or plant start-up on-going monitoring efforts will be necessary.

A. Continuous monitoring of wind speed and direction accompanied by intermittent scheduled air particulate sampling prior to and after permit issuance in accordance with Guidelines for the Development of a Quality Assurance Program, Reference Method for the Determination of Suspended Particulate in the Atmosphere, Publication E.P.A.-RA-73-028B, Washington, D.C., June, 1973, should be initiated.

The nature and location of wind monitoring equipment should be determined with the assistance of DSL and AQB personnel. If an established weather station is continuously monitoring nearby, site specific wind monitoring may not be necessary, or the effort could be shared cooperatively with other operators in the area.

B. Particulate sampling need be accomplished by establishing a network of samplers as close as possible to the proposed permit boundary, being sure to adequately sample downwind from the area of main permitted activity.

a. Clean Air Act of Montana, Sec. 69-3909, subsec. 12, May 7, 1967.
b. Federal Register, Volume 36, No. 84, Friday, April 30, 1971.
c. Federal REgister, Volume 34, No. 235, Thursday, Dec. 5, 1974
d. Federal Register, Volume 41, No. 86, Montana, May 3, 1976.

Monitoring stations or sites will generally transect the proposed mining or plant site areas in predominant wind patterns.

C. Background or operation monitoring may include any or all of the following parameters:

a. Particulates
b. Particle size distribution
c. Elemental analysis
d. Ambient gaseous pollutants
e. Source emission testing and monitoring
f. Visibility measurements
g. Meteorological parameters
h. Soil erodibility potential
i. Vegetative cover analysis

D. Upon start-up of an operation monitors would generally be deployed to sites near sources known to emit higher pollutant concentrations such as open coal storage piles, haul roads, crushing facilities, overburden stripping, reclamation activities, load-out operations, emission stacks, etc.

To insure high quality data collection in sampling efforts, strict adherence to current Federal reference methods and State AQB procedures will be expected. Where no reference methods exist, sampling and analysis procedures will be approved by AQB. State quality assurance procedures will apply to all phases of data collection.

II. INVENTORY OF SOURCE

As a basis for better understanding the operation's potential for generating coal and soil dust, an inventory of equipment and activities should be developed. Construct a list as outlined by the example below.

A. Type of vehicle, miles traveled per unit time, tons hauled, tons moved, hours of operation

B. Total tons and yards of dirt and coal handled by shovels, draglines, etc. per unit time

C. Coal crushing and conveying system, conveyor length, number and location of crushers

D. Number of acres of disturbance each year

E. Blasting, size of shot patterns and number of shots.

III. METHODS OF ABATEMENT

The means of abatement of dust are numerous and will vary with different operations, but the following are examples of abatement activities and hardware which should be listed in an application as Air Quality Maintenance Plans.

A. Road surfacing or binding agents

B. Road watering by trucks or irrigation systems

C. Speed control and prevention of the overloading of trucks and scrapers

D. Covering conveyors, crushers and loadout systems - use of baghouses

E. Minimize outdoor handling of coal - reduce spontaneous combustion

F. Schedule soil and spoil handling to most favorable seasons or weather period to avoid excessive dust emissions

G. Blasting - control of.

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G. Blasting - control of.

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VEGETATION GUIDELINES

The objectives of a vegetation inventory are:

1. To comply with the intent and requirements of the law, especially Section 6(3)(k) which calls for a map which shall "show a listing of plant varieties encountered in the area to be affected and their relative dominance in the area, together with an enumeration of tree varieties and the approximate number of each variety occurring per acre on the area to be affected, and the locations generally of the various kinds of varieties of plants, including but not limited to grasses, shrubs, legumes, forbs and trees;" and Section 9(2) which calls for the deletion of certain areas if they possess special, exceptional, critical, or unique characteristics as related to biological productivity, ecological fragility, ecological importance, or scenic, scientific or recreational significance;

2. To fulfill requirements of the rules and regulations adopted pursuant to the law;

3. To assist the applicant in formulating a revegetation plan providing for a "suitable permanent diverse vegetative cover capable of:
   a) feeding and withstanding grazing pressure from a quantity and mixture of wildlife and livestock at least comparable to that which the land could have sustained prior to the operation;

   b) regenerating under the natural conditions prevailing at the site, including occasional drought, heavy snowfalls, and strong winds; and,

   c) Preventing soil erosion to the extent achieved prior to the operation." (Section 12)

4. To provide for a history of the area affected as it relates to revegetation success, bond release, possible research projects, or state and regional resource management objectives.

In order to fulfill the objectives outlined above, the following guidelines have been drawn up.

1) After receipt of the law, rules and regulations, and guidelines, the researcher shall present a study proposal to the Reclamation Division for review.
2) After evaluation of the proposal and field inspection, meetings will be set to discuss and modify the proposal. At the conclusion the plan will be approved by the Reclamation Division.

3) During the survey close contact must be maintained with the Reclamation Division to assure that misunderstandings and unforeseen problems are cleared up.

Rule (2)(b)(i) - "A vegetative map acceptable to the Department which delineates community types based on two (2) or more dominant species. Dominant species are those which by their structure, number or coverage have the greatest functional influence on the type."

1. Map should be an acetate overlay of the soils map and the aerial photo.

2. As with all studies, the methods and procedures used in mapping should be included in the narrative.

3. Accuracy of the map (smallest unit mapped will be one (1) acre or less if twentyfive (25) or less acres are affected, or two (2) acres or less if more than twenty-five (25) acres are affected.

4. For the purpose of this application, community type is defined as a collective term for those areas supporting or capable of supporting the same plant community.

Rule (2)(b)(ii) - "A narrative describing the community types by listing associated species and discussing environmental factors controlling or limiting the distribution of species. Current condition and trend shall be discussed for each community type or portion thereof if significant differences exist within a type."

1. Quantitative information should be collected for each type. Included should be:

   a) A complete listing of species;
   b) Percent canopy coverage for each species, bare ground, and litter; number of trees per acre for each species;
   c) A measure of production (above ground at peak of growing season and AUMs the type is supporting, and AUMs the type could sustain);
      NOTE: Production shall be expressed as pounds per acre of oven dry weight and shall be broken down into categories as follows: Perennial grasses, annual grasses, forbs and shrubs.
   d) Methods used should be described completely;
   e) Results must be statistically valid and reproducable.

f) All transects, plots or other locations which, through study and observation have been utilized to define vegetative characteristics and communities indigenous to an area shall be marked on the ground and clearly located on the community type map. This marker shall be clearly visible and shall have affixed to it some form of identification which shall be referenced in the vegetation surveys submitted to this Department. All field notes concerning observations at these marked areas shall indicate the location of points of observation relative to the location of the marker.

g) A copy of all field notes on approved forms.

2. Discussion of environmental factors for species and types: slope, aspect, soil, grazing, fire, etc.

3. Condition and trend by S.C.S. or comparable methods.

4. Oblique color transect photos for each type with location mapped.

Sample size - size will vary with sample plot size. Plot size is left to the discretion of persons doing the survey. Sample intensity should be approved with the department prior to the study.

1. Canopy cover.

Sampling should be stratified throughout the areas of occurrence of each type. The number of samples for each type should be proportional to the amount of area of that type and to the variability of the type. A minimum of two samples should be taken for the smallest type. Sampling adequacy will be determined according to the following:

1. Stratification
2. Proportional to the area and variability
3. Coefficient of variation equals 30 percent or less

2. Production

While production sampling may be less intensive it should follow the same criteria as for canopy cover. i.e. samples should be stratified and proportional to the area and variability. A minimum of one sample per type is required for the smallest type. If possible production measurements should be taken on areas excluded from grazing.

3. Inadequate sampling will result in an application being declared incomplete.

Rule (2)(b)(iii) - "The vegetative survey shall be correlated with the soil survey." Explain the relationships between community types and soil types and list what community types occur on what soil types.

It is recommended that a cooperative effort be established between the operator and the Department in the designation of a land area within or adjacent to the permit area for the purpose of continuous observation of vegetative responses to climatic changes which may also affect newly established vegetation in reclamation areas. Such land areas, designated as Control Areas, should contain the following characteristics:

1. A significant representation of species and community types naturally indigenous to the area to be affected. The degree of significance may be determined by comparing the control area through information derived from pre-planning inventories of areas to be disturbed.

2. A significant representation of soils and topographic aspects indigenous to the area to be affected.

3. Protection from uncontrolled grazing by domestic livestock.

4. Protection from changes or disturbances related to the mining operation.

At such time as bond release is applied for or if the department determines problems exist a comparative chemical analysis of vegetation on the reclamation and control areas may be required.

Preplanning Inventories shall be designed to facilitate correlation of information with observations and studies of reclamation areas. Methods utilized in the quantitative analysis of undisturbed vegetation must result in data which is statistically compatible or readily convertible for use in evaluating or comparing with observations or reclamation areas. All parameters cited in the study of community types, as found in these guidelines, will be utilized to evaluate reclamation areas.

Whenever possible, transects, plots, observation points, etc. used for vegetation observation shall be utilized for wildlife study. However, the multiple use of observation points should not preclude the quality of either study.

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WILDLIFE SURVEY GUIDELINES

These guidelines should be used as a basis to set up the wildlife survey on areas to be mined for coal. The wildlife survey should be considered as a study of the overall ecology of the area.

Important species or key species to be studied cannot be named beforehand. Any organism may be important or critical in various areas. Although game animals are important and convenient species to study as techniques are well known for most game species, the study should also identify non-game species, and consider the total ecology of the area to determine important species and/or habitats within the study area.

The law directs the department to approve applications assuming no jeopardy to species of wildlife or domestic stock. As wildlife is not limited to game species, the permanent loss of productivity of any species is grounds for denial of a permit. Pragmatically this concept places a great importance and dependence on the success of reclamation and upon the ability to identify habitats critical to organisms in and around the area to be mined.

The duration of the study will be in two phases with first a wildlife and wildlife habitat inventory before any disturbance. The second, monitoring the on-going operation to analyze the success of reclamation and to monitor various indices for trend comparisons.

The law calls for seasons of use by each species which basically means a minimum of one year premining inventory, taking into consideration climatic conditions which may limit or expand the use of certain species on the area any particular year. A preferable study design would include two (2) winter seasons during the course of the study. The monitoring activity shall be carried out until mining in the area is completed and reclamation is considered complete.

The scope of work as defined by field time should follow these guidelines for minimum field work:

Pre-mining inventory

field time	=	1 year on the site, a biologist working on the site for 1 year considering a 5 day work week
aerial coverage	=	2 times/month for 1 year

Monitoring activity

field time = 100 man days/year (not consecutive)

aerial coverage = 1/month

The above time frame is that required for large operations in areas that have not been studied previously by other researchers.

Major Objectives Of The Survey

I) To obtain a list of fish and wildlife species using the area. Wildlife is not limited to game species. Special attention must be given to the possibility of rare and endangered species utilizing the area.

II) To obtain relative population density estimates of major wildlife and ecologically important species. The importance of any particular species will be based upon the presence of critical habitats.

III) To assess different habitat types within the area, to delineate wildlife use of these types and to determine the degree of wildlife dependence on these types. Standardization of habitat typing within our region should be attempted. Vegetation work should be conducted to properly evaluate where to place transects or trap lines.

IV) To show season or seasons of use of an area, by each species present.

V) To monitor the area and comparable control areas on a continuing basis compiling trend data for analysis. The monitoring phase of the study will be reduced in the scope of field time, as noted previously, except in case of continued expansion or multiple mine activity.

Basic objectives of the monitoring activity will be as follows:

A) Collect trend information utilizing indices used in the premining inventory. Monitoring over the long term will answer questions of adequacy of restoration of wildlife habitat in relative terms.

B) Analyze the effects of mining disturbance upon the ecology of the area.

1) Determine displacement effect around the mine area and any migration into or away from mining areas by certain species.

2) Determine effectiveness of reclaimed areas in terms of support and maintenance compared to native biological productivity.

3) Add to the list of species utilizing the mining area as climatic and other changes result in additional "seasons of use" data.

Method Of Wildlife Survey

The following techniques are being used to fulfill the objectives outlined previously. All techniques are subject to modification to fit the requirements of specific situations. It is also inherent in any study design that allowances for expanded research be made in case unforseen problems arise.

1) After receipt of the law, rules and regulations and guidelines, the researcher shall present a study proposal to the Reclamation Division for review.
2) After evaluation of the proposal and field inspection, meetings will be set to discuss and modify the proposal. At the conclusion the plan will be approved by the Reclamation Division.
3) During the survey close contact must be maintained with the Reclamation Division to assure that misunderstandings and unforeseen problems are cleared up.

Standard techniques are as follows:

(1) Literature research of all available, and applicable wildlife information concerning the organisms in the study area.

(2) Communications with local residents, Fish & Game personnel, or any knowledgeable parties.

(3) Direct observations of wildlife is a basic component of the survey. Observation routes should be set up to cover the whole area. Location and frequency of use of these routes must be tabulated and approved observation sheets utilized. Observations should be made utilizing coordinated system to locate each observation in the study area. Detailed field notes are necessary. Information such as: date; time of day; climatic conditions; condition and sex of the organism; activity of the organism; flight, feeding, etc.; habitat type being utilized are examples of the information that should be tabulated. Maps must be submitted showing routes to be used for ground and aerial runs.

Aerial observations surveys should be explained in detail. Information concerning dates of flights, duration of flights, type of plane, route of flights, altitude and speed should be explained.

(4) Small mammal trap should be set up to monitor population trends in different habitat types. The techniques used should be applicable to testing reclaimed areas. Some grids and/or traplines should be in areas which won't be disturbed for comparison purposes. Spring and fall trapping should furnish necessary information.

(5) Crowing counts should be made when applicable. This technique is a standard auditory index census and will furnish pheasant trend information.

(6) Dancing and strutting grounds should be censused at least twice a spring for trend information. In some cases it may be valuable to visit the grounds in the fall also. In cases where habitat needs of the population utliizing the ground.

A breeding bird survey should be conducted to furnish information for the species list, territory, habitat use by certain species, etc.

Special attention should be paid to nesting raptors and colonial nesting birds. Disturbance of nesting birds should be kept to a minimum until more intensive studies are started.

(7) The use of various habitats in and around the area for food, cover, escape routes; etc. should be noted and discussed. Utilization of various habitats or vegetation types for food sources should be documented by browse transects, time observation of feeding animals, scat examination and stomach or crop examination of road killed or hunter killed animals.

(8) A complete inventory of aquatic vertebrates and invertebrates in waters receiving surface or ground water from the mine area should be made. Aquatic plants, both macrophytes and algae (including diatoms), also should be inventoried and monitored. Aquatic biological studies should follow one of the listed references:

1. American Public Health Association. 1971. Standard Methods the Examination of Water and Wastewater. Thirteenth Edition, A.P.H.A., Washington, D.C.

2. Environmental Protection Agency. 1973. Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents. National Environmental Research Center, Cincinnati, Ohio.

Water quality data will be required for such streams and bodies of water on a periodic basis. More detailed analysis of the above items will be required on a site by site basis depending upon the nature of potential aquatic impacts.

The above guidelines outline the objectives which must be adhered to and outlines some basic techniques for wildlife surveys to be conducted. In the planning stages of the study detailed descriptions of each study technique must be submitted to the Reclamation

Division biologist for review. Information concerning field time and intervals of field time must be clearly defined before approval is given. The planning phase should incorporate valid statistical testing into the study design. Data should be analyzed for statistical significance.

There are many different techniques which may be employed to adequately study the ecology of the area. All techniques must be outlined in detail to the Reclamation Division biologist before study approval is given. Any changes in the study design should be brought to the attention of the Reclamation Division biologist for concurrence before implementation.

Reclamation Division
Department of State Lands
Helena, Montana 59601

SOILS AND OVERBURDEN GUIDELINES
1977

I. Soils - Premining

A. Introduction

The basic goal of a pre-mining soil survey is to meet the requirements and objectives of the law and the pursuant rules and regulations in:

(1) salvaging all available topsoil for reuse on regraded spoils for the purpose of establishing a suitable vegetative cover, and

(2) delineating and sampling the soils in enough detail to determine their suitability and the depths to which they should be salvaged. An associated objective is to obtain an estimate of the total volume of suitable topsoil available for salvage on the area of land affected.

The term "topsoil" as used here and that is interpreted from the definition in the law will be defined as any surface soil material determined suitable for topsoiling, including A, B, and C horizons, if present.

It is to be emphasized that a company should contact the Department prior to initiating any soils or overburden work in order to delineate any site specific characteristics or problems that may require modifications of the following procedures.

B. Soil Inventory and Maps

The soil survey inventory shall cover two time periods: the entire life of the operation, i.e., the total area to be affected; and the twelve month area to be permitted.

(1) Maps

The soils information shall be presented to the department on a set of maps covering each of these two time periods and meeting the following criteria:

a. Enlarged aerial photographs are desired as base maps at a scale of 1"=400';
b. Duplicates of each set must be submitted;
c. All maps shall be oriented to the north with a north arrow on each map. All maps shall have section corners, township and range controls clearly delineated and labelled;

d. The sampling locations shall be shown on the maps;
e. A mylar showing boundaries of future mining and permit areas shall be submitted to overlay the soils photo for the entire life of the operation.
f. The maps are to clearly show all soil mapping unit boundaries (the delineated area) and assigned numbers.
g. A soil survey legend will be attached to the soil maps and will consist of a listing of all mapping units with assigned numbers and the depth(s) at which the company desires to strip topsoil for salvage.

(2) Specifications of Inventory

The Department desires to have a detailed soil survey by soil series and phases.

a. Describe and sample for analysis all major and minor soils that are:

1. Highly contrasting (differ markedly in physical and/or chemical properties from the other soils) and comprise 15 percent or more of a delineated area.

2. Low contrasting soils that are inclusions within a delineation and comprise 25 percent or more of a delineated area and also meet the minimum acreage requirements listed below in b.

b. S.C.S. soil surveys may be used, but refinement and additional information will be supplied to the Department for all delineations that are associations, complexes, undifferentiated and single (monotaxon) mapping units as follows:

Areas of minor or included highly contrasting soils that are two (2) acres or larger in size and low contrasting soils of five (5) acres or larger in size will be delineated on the soil map. Such soils are to be represented by a profile description and sampled for analysis.

c. Narrative Description of Soils

A soil survey narrative will be submitted and will consist of (1) a description of each soil series and its classification to family according to current soil taxonomy (Soil Survey Staff, 1975), and (2) a description of each mapping unit by slope (dominant slope and range), kinds of soils and the percent of each kind of soil in the mapping unit; also, whether or not the soils are typical for the series. Describe the position of the soils in the landscape.

D. Sampling

(1) Vertical Distribution

Sample representative soil profiles of each soil phase to a depth of eighty-four inches (84") or to indurated bedrock or clay shales, whichever occur first. Underlying soft loamy, silty or sandy shales are to be sampled to a depth twelve inches (12") below the weathered soil material. After the profile has been exposed and described, collect representative continuous two (2) quart (top to bottom of horizon) samples from each specific genetic horizon except the surface six inches (6"). The surface layer is to be sampled from zero (0) to six inches (6"). Each succeeding sample will be taken from each succeeding genetic horizon or important layer or contrasting sub-horizon or layer. No samples are to be collected from layers less than three inches (3") thick. Horizons or layers greater than twenty-four inches (24") thick will be split so that no sample exceeds twenty-four inches (24") in thickness.

(2) Horizontal Distribution

Basically, the precise number of sampling locations required for each soil phase should be based on a site-specific evaluation of what is needed to adequately characterize the qualitative and quantitative nature of the soils. As a general guideline, profile descriptions and sampling for analysis are to be conducted at a minimum of two (2) locations for each soil phase. However, the person doing the soil survey and collecting the samples is encouraged to describe and collect as many

samples as is necessary, in his or her professional judgement, to adequately characterize the soils. For example, large, scattered, and heterogeneous delineations may very well require more than two sampling locations for profile descriptions and/or analysis of samples therefrom. This is especially true with regard to soils that vary considerably in the level of some characteristic, such as soluble salt content, that is potentially undesirable. In general, recognizable "homogenous" subunits (on the basis of topography, vegetation, etc.) of each soil phase should be sampled, insofar as these subunits have significantly different chemical and physical properties.

On the other hand, some extremely rocky or shallow soils that may not be suitable for salvage may require only a profile description and need not be sampled for analysis. It is advisable for the person doing the survey to contact the Department as these sampling problems or peculiarities arise. The Department will assist in selecting and plotting sampling sites, as requested. The Department reserves the right to require more samples, if, after reviewing the initial results of the survey, considerable variation is evident.

(3) Sampling techniques

The continuous two (2) quart samples referred to in (1) can be conveniently taken with a chrome-plated spade. Alternatively, the samples may be taken from the surface with a spoil coring tube. Soil samples should then be placed into clean polyethelene plastic bags and transported to the laboratory as soon as possible. The samples should not be exposed to extremes of temperature during transport. If the soils require shipping or storage for extended periods of time, they should be air-dried first (U.S.D.A. Handbook 60, 1954).

The most important consideration in sampling and transport is to prevent contamination and changes in chemical and physical properties of the soils to the maximum extent possible.

It is to be recommended that whenever possible an amount of each sample be taken that is somewhat in

excess of that required for the following analyses. This is to insure adequate amounts for these and any additional analyses that may be required.

(4) Sample Site Location

A legal description of the sample site will be part of the profile description. This is to be in metes and bounds, e.g.: 100 ft. N, 200 ft. W from the SW cor. Sec. 26, T1N, R5E (any 1/4 corner, section corner or center of section may serve as a reference point).

D. Analyses

Each sample will be prepared and tested for the following parameters by the indicated procedures:

Soil Survey Analysis	Procedure
1. Preparation of soils for analysis and subsampling	U.S.D.A. Handbook 60, 1954 - Diagnosis and Improvement of Saline and Alkali Soils, pp. 83-84; all analyses should be conducted on samples that have been passed through at least a 20-mesh sieve.
2. pH (determination on paste)	U.S.D.A. Handbook 60, Page 102.
3. Conductivity mmhos/cm on saturation extract.	U.S.D.A. Handbook 60, Pages 88 and 89.
4. Saturation percentage	U.S.D.A. Handbook 60, Page 84, Method 2 and 3a
5. Calcium Report in meq/L. on the extract.	Preparation of extract U.S.D.A. Handbook 60, Page 84, Method 2 and 3a. Analysis by atomic absorption spectrophotometry (see Perkin-Elmer Analytical Methods).
6. Magnesium - Report in meq/L.	Same as for Calcium.
7. Sodium - Report in meq/L.	Same as for Calcium.

Soil Survey Analysis	Procedure
8. SAR (Sodium Adsorption Ratio)	U.S.D.A. Handbook 60, Page 26, $SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{+2} + Mg^{+2}}{2}}}$ Where Na^{+2} Ca^{+2} and Mg^{+} are the concentrations of those ions found in 5,6, and 7 above.
9. Boron - Hot water extract reported as ppm.	A.S.A. Agronomy Monegraph #9, 1965. Methods of Soil Analysis, part 2. Method 75-4, pp. 1062-1063.
10. Particle size distribution (methanical analysis) Report % sand, % silt, and % clay, as well as the U.S.D.A. textural classification.	A.S.A. Agronomy Monograph #9, part 1, Method 43-5, pp. 562-566. If EC is 4 or more mmhos/cm include field texture determination.

If a company would like to utilize different procedures, it should contact the Department prior to any analysis. Other tests may be required by the Department, depending on the nature of the soils. It is recommended that any excess of soil samples be retained by the company in case additional or a repetition of analysis is required.

II. Topsoil Salvage and Redistribution

A. All of the previous information should be utilized in a narrative discussion by the company relating to the suitability of each soil for salvage and the depth(s) to which the company recommends salvage should take place for each soil. Also an estimate of the total volume of soil available and the approximate depth that soil can be redistributed over the permit area and over the course of the life of the operation will be given.

The company should also consider the desirability of salvaging surface horizons (A and possibly B horizons) separately from subsurface soil (C horizon) since the surface horizons contain the greatest concentrations of organic matter, important plant nutrients, and microbial activities. The Agricultural Research Service in Mandan, N.D. (1977) has recently reported on the benefits that can accrue to vegetative performance when separate salvage and redistribution occur on mine

spoils. Another consideration is that certain chemical and physical properties of subsoils, which if mixed with surface horizons, may reduce the quality of all respread topsoil to less than desirable levels. An example of which may tend to reduce the structural stability of aggregates of medium to fine-textured soils (Cmodt, et. al. 1975).

B. During topsoil stripping operations, the Department will require that small undisturbed areas of each soil phase be left until inspected by Department personnel. A stake on each of these areas will show the depth to which the soil is to be excavated as is stated in the permit application.

C. The retopsoiled layer shall be fairly uniform in thickness over the regraded spoils. This can be controlled with stakes, uniform "lifts" or other means. Each applicant will respond to this with a description of the procedure or method that will be used to insure that a fairly uniform layer will be spread. All methods will require Departmental approval.

III. Overburden and Innerburden (premining)

A. Introduction

The rationale for premining overburden information is to identify zones, layers, and strata that may have undesirable chemical and physical characteristics rendering the material unsuitable as a rooting medium and thus requiring burial pursuant to rule 26-2.10(10)-S10310(1)(b) and (c).

The material may also have characteristics which could adversely affect groundwater after mining. Thus identification of such material is necessary in order to properly plan and evaluate a mining and reclamation plan relative to protecting post-mining above and below ground resources. The company should include a discussion of overburden analytical results in this context.

B. Sampling

(1) For the annual application, a minimum of one (1) hole per 2,000 feet or less, relatively evenly spaced, is required within the area to be permitted. Additional holes will be required in areas that are not similar in chemical, physical, geologic or hydrologic characteristics. Core drilling is preferred, but in any event, drilling mud, high

zinc grease, and other contaminating circulating materials must be avoided (Power and Sandoval, 1976).

(2) The holes will be clearly marked on maps and will include the elevation at the hole collar. Test hole logs will be carefully kept and submitted as

(3) Sampling of the test holes will be conducted on all overburden (including topsoil) and innerburden down to the last economic coal seam (see coal guidelines). Samples will be taken of the total thickness of each stratum in not greater than ten foot (10') intervals and not less than two foot (2') intervals. For instance, if a sandstone stratum is thirty feet (30') thick, then three (3) samples of ten foot (10') lengths are required. Further, if several alternating shales and sandstones are together within two feet (2') then one (1) sample is required for the two foot (2') interval. Each stratum should be designated by thickness and depth.

(4) Again, careful handling is an absolute necessity to avoid contamination of the samples and the production of anomolous results in the analysis. Samples should be immediately placed into plastic bags and transported to the laboratory as soon as possible. The samples should not be exposed to extremes of temperature before analysis. If the samples are to be stored or shipped over extended periods of time, they should be air-dried first.

C. Analysis - The preparation and testing requirements are the same as for soils. In addition the following analyses utilizing the indicated procedures are required:

	Procedure
1. Copper (ppm)	DTPA extractable - Soil Science Soc. of America Proceedings, Vol. 35, No. 4, 1971, pp. 600-602. Analysis of Extract by atomic absorption spectro-photometry.
2. Cadmium (ppm)	DTPA - Same as copper

		Procedure
3.	Iron (ppm)	DTPA - Same as copper.
4.	Lead (ppm)	DTPA - Same as copper.
5.	Manganese (ppm)	DTPA - Same as copper
6.	Zinc (ppm)	DTPA - Same as copper.
7.	Nickel (ppm)	DTPA - Same as copper.
8.	Mercury (total ppb)	Acid soluble soil Hg and analysis by cold vapor technique. Manual of Methods for Chemical Analysis of Water and Wastes, E.P.A., 1974. p. 137, procedure 8.1.
9.	Selenium (ppm)	Hot Water Extract - sum of water soluble selenate, selenite, and organic Se. Extraction Procedure - A.S.A. Monograph #9, part 2, 80-3.2.2, p. 1122. Analysis of extract by sodium borohydride method, Advances in Vapor Generation, 1974, presented at Silver Anniversary, Pittsburg Conference on Analytical Chemistry and Applied Spectroscopy, Cleveland Ohio.
10.	Molybdenum (ppm)	Acid Ammonium oxalate extraction A.S.A. monograph #9, part 2, pp. 1054-1057. Analysis by thiocyanate procedure in this reference or by atomic absorption spectro-photometry.
11.	Nitrate (NO_3^-) (ppm)	Extraction by $CaSO_4$ solution and analysis by phenoldisulfonic acid method, A.S.A. monograph #9, part 2. p. 1212-1214. or Extraction by 2N NaCl (instead of KCl) and analysis by steam distillation or microdiffusion, A.S.A. Monograph #9, part 2, pp. 1185-1212.
12.	Ammonium (NH_4^+) Exchangeable + soluble (ppm)	Same as second procedure described for nitrate above.

13. Additional tests may be required depending on the area and the nature of the spoil material. Desired deviations from

these procedures should be discussed with the Department prior to analysis.

14. Special care will be taken in sampling, preparation and analysis to prevent contamination of the samples with the trace elements being analyzed. This will include, but not be limited to, avoiding the use of the following materials: galvanized steel, brass, bronze, and rubber; and borosilicate glassware for boron determinations. The use of all-glass distilled water in molybdenum analysis is important.

15. The concentration units referred to above (ppm or ppb) and in all soils and spoils analyses elsewhere should be relative to some equilibrium moisture content less than about 5% on a dry weight basis. A dessicator may be needed to attain these low moisture levels for some samples whereas this may simply be an air-dried weight for others.

D. Plant growth tests may be required by the Department on selected samples after soil, overburden and innerburden analyses have been reviewed by the Department. Samples will be seeded to Horsford barley and/or other species as directed by the Department.

Because of the variety of mining and reclamation techniques the Department may vary the above requirements to meet an unusual problem. However, for the purposes of the application for surface mining permit, the above data are considered to be the criteria to be used.

IV. Sampling of Regraded and Retopsoiled Spoils

A. Introduction

The Department desires that a sampling and testing program be conducted on the prepared surface to be revegetated in order to determine if special spoil handling procedures have been effective, if pre-mining overburden information has adequately predicted the nature of regraded material, and to determine fertilizer needs of the topsoiling material. Sampling of regraded spoils and respread topsoil shall be conducted prior to revegetative activities.

B. Sampling

(1) Spoils

Each area which has been regraded with the ongoing mining operation will be tested. To the extent possible, spoils should be sampled, analyzed and the results reviewed by the Department before topsoiling. In any event, this may be required if special spoil handling has occurred or other considerations warrant it. Sampling shall be conducted to an eight (8) foot depth at about one (1) sampling location per two (2) acres of regraded surface, relatively evenly spaced. A map showing sampling locations and a delineation of the regraded area under consideration shall be submitted.

Each spoils sample will be divided into two (2) increments of four (4) feet each which shall be analyzed separately and clearly designated. Sampling can conveniently be done by a soil coring tube. All techniques referred to previously in the careful handling of soils and overburden to prevent contamination, etc. are applicable here as well as for the samples of respread topsoil. Parameters to be analyzed and associated procedures will be the following:

Regraded Spoils	Procedure
1. Preparation and subsampling	Same as in Soil Survey.
2. pH	Same as in Soil Survey.
3. Conductivity	Same as in Soil Survey.
4. Ca, Mg, and Na	Same as in Soil Survey.
5. SAR	Same as in Soil Survey.
6. Particle Size Distribution	Same as in Soil Survey.

The Department may require additional samples analyzed or different tests conducted, depending on results of overburden analysis.

(2) Respread Topsoil

The sampling techniques, horizontal sampling intensity, and mapping requirements are the same as for regraded spoils. However, only one (1) sample comprising the total thickness of topsoil need be taken. In addition, the total depth of topsoil at each sampling location should be recorded and submitted with test results. Analyses shall be done for the following parameters using the indicated procedures:

Retopsoiled Layer	Procedure
1. Nitrogen - Report as ppm the sum of nitrate nitrogen (NO_3-N) and ammonium-nitrogen (NH_4-N) in the soil.	Same as for Overburden and Innerburden analysis
2. Phosphorus - Reported as ppm phosphorus in the soil.	Phosphorus extractable by the Sodium Bicarbonate method, analysis by colorimetry; A.S.A. Agronomy Monograph No. 9, part 2 pp. 1044-47, Method 73-4.4.
3. Potassium - Reported in ppm	Ammonium acetate extraction and analysis by atomic absorption or flame emission - describe procedure. ASA Agronomy Monograph No. 9, part 2. Method 71-3, pp. 1025-1027; and Perkin-Elmer, p. Ay-1.

Additional analyses may be required depending on the results of the initial soil survey.

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Reclamation Division
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WATER RESOURCE GUIDELINES
1977

The following guidelines are to be followed in submitting hydrologic data during preplanning, mining and post-mining/reclamation phases of a company's operation. Under existing state statute and pursuant rules and regulations, it is necessary to characterize the pre-mine environment so that preplanning and permit review may consider potential impact on surface and ground water. During mining and post-mining phases, it is necessary to monitor surface and ground waters to detect changes in these systems.

Inherent in the guidelines is the need for communication between the permit applicant and the Department of State Lands. Generally, the Department should review research proposals prior to their initiation.

The Department reserves the right to alter guidelines requirements as field experience, demonstrations or research yields a better understanding of hydrologic processes in Montana's mining areas. The nature of site specific data may be changed as generalized principles are delineated. The extent of water quality analyses may likewise be changed.

Some revision of these guidelines may be necessary to consider the underground mining of coal and uranium.

NOTE: Prior to undertaking the observation well drilling program and the monitoring of ground and surface water streams, the company shall discuss its study plan with the Department for possible revision and approval.

I. PREPLANNING

A narrative and graphic account of groundwater hydrology including the following information shall be submitted.

A. Groundwater Hydrology and Quality

1. Generalized groundwater basin study

a. A hydrologic map (scale 1:24,000) of the shallow groundwater basin which directly supplies groundwater to the mined area shall be submitted. The basin outline shall follow known hydrologic barriers and drainage divides. The map shall distinguish all stream channels, recharge and discharge areas, all aquifer outcrops, and all known faults. (Basin limits are to be approximated using published data, well records, and known geologic conditions. Basin limits will extend downgradient or downstream to the first major stream).

b. Estimates will be made of projected source and amount of groundwater use during and after mining operations.

2. Detailed groundwater study

a. For a two mile radius about the perimeter of the proposed area of land to be affected (as defined in Section 50-1036(5)):

1) Contour maps of water table and/or potentiometric surface of water in each aquifer to be disturbed by mining shall be submitted. A similar map shall be submitted for the highest undisturbed aquifer within this area, if that aquifer is within 100 stratigraphic feet of the maximum mining depth. A map scale of 1:24,000, or maps with greater detail, shall be used on a base map showing ground surface contour, drainages and section lines. Observation wells and other data points related to the water table and/or potentiometric surface also shall be indicated on these maps. Groundwater flow directions shall be indicated on each water table and/or potentiometric contour map. The observation well drilling program necessary to fulfill this requirement shall be reviewed by the Department prior to initiation of the drilling program. The drilling program shall be designed to identify any groundwater which is reasonably determined to be affected by the mining operation. Observation wells in each aquifer shall be constructed to ensure reception of water from only that aquifer. Aquifer is defined in Section 50-1036(21). Where an aquifer is characterized by mixed lithology, as in an overburden sequence of sands and silts, an aquifer zone of varied lithology may be considered. Water level in at least one well in each aquifer shall be continuously recorded and a hydrograph submitted to the Department.

2) Complete water analyses, as described in Part (A.2.f.) of Preplanning, shall be submitted for all wells, except oil wells, injection wells, or wells whose source of water is an aquifer deeper than 100 stratigraphic feet below the lowest coal seam proposed to be mined.

3) Any alluvial valley where groundwater is present at sufficiently shallow depths to allow natural irrigation of plants from a groundwater source shall be identified on the same maps which show wells and springs (see subsection A.2.b. of preplanning. Any sub-irrigation farming within a five mile radius of the permit area shall be identified as to acreage farmed, number of yearly harvests, crops grown, and estimated gross monetary value of crops grown. These farms shall be located on the same maps indicated above.

4) Field measures of hydraulic conductivity and transmissivity, based on aquifer pumping tests, for each aquifer mapped in subsection A.2.a.1) shall be submitted. Other data, such as drawdown characteristics, radius of influence, coefficient of storage and specific capacity, may be required.

5) Water quality samples of each aquifer mapped in subsection A.2.a.1) shall be collected in at least one observation well upgradient and at least one observation well downgradient of the proposed area of land to be affected. Sampling shall be repeated six months after the first samples are collected. As with all groundwater tests, sampling shall be immediately preceded, if reasonably possible, by continuous pumping of not less than three times the volume of water present in the well.

6) If a nearby alluvial aquifer may reasonably be expected to be affected by mining, water level in at least one observation well shall be monitored at least monthly, and the data for a one year period shall be submitted.

7) Lithology and thickness of all aquifers mapped in section A.2.a.1) shall be submitted.

b. A listing of all existing wells, including oil and injection wells, and springs within a four mile radius of the perimeter of the proposed area of land to be affected shall be submitted. Wells and springs shall be labeled and identified on a USGS 7 1/2-minute topographic map, if available, or similar scale map. The following information

shall be included: location (township, range, section, quarter, quarter, quarter), land surface elevation, method of determining land surface elevation, well depth, method of determining well depth, and aquifer source(s). Within a two mile radius of the perimeter of the proposed area of land to be affected, the following additional information shall be submitted: surface owner, water use, depth to static water level (to an accuracy of ± 0.1 foot), discharge during pumping, and discharge from springs.

c. A description of alternative groundwater supplies, including depth and quality of waters, which could be developed to replace water supplies diminished in quality or quantity by mining activities.

d. Mining and post-mining groundwater conditions including, but not limited to, water levels and/or potentiometric surface and water quality shall be monitored by the operator in a Department approved monitoring program.

e. The Department will assist the operator in obtaining access to surrounding, privately owned lands, so that data required in Preplanning may be obtained. An application will not be considered incomplete, if data required in Preplanning cannot be gathered and submitted, due to refusal of access to these lands.

f. The following parameters constitute a complete analysis of groundwater. The parameters and the units (milligrams per liter (mg/l) and/or milliequivalents per liter (meq)) in which the parameters will be expressed are as follows:

PARAMETER LIST

Specific electrical conductance in micromhos per centimeter at 25° C

Laboratory hydrogen ion concentration in standard ph units

Total alkalinity (mg/l as $CaCO_3$)

Total acidity (if ph is less than 7.0) (mg/l as $CaCO_3$)

Sodium absorption ratio

Total dissolved solids (mg/l)
(calculated or measured)

Aluminum (Al) (mg/l)

Bicarbonate (HCO_3) (mg/l) (meq/l)

Boron (B) (mg/l)

Cadmium (Cd) (mg/l)

Calcium (Ca) (mg/l) (meq/l)

Carbonate (CO_3) (mg/l) (meq/l)

Chloride (Cl) (mg/l) (meq/l)

Copper (Cu) (mg/l)

Flouride (F) (mg/l) (meq/l)

Iron (Fe) (mg/l)

Lead (Pb) (mg/l)

Mercury (Hg) (mg/l)

Nitrate (NO_3 as N) or nitrate plus nitrite ($NO_3 + NO_2$) as N) (mg/l) (meq/l)

Orthophosphate (PO_4 as P) (mg/l) (meq/l)

Potassium (K) (mg/l) (meq/l)

Selenium (Se) (mg/l)

Sodium (Na) (mg/l) (meq/l)

Sulfate (SO_4) (mg/l) (meq/l)

Vanadium (V) (mg/l)

Zinc (Zn) (mg/l)

The initial samples taken should include analyses for Nickel, Molybdenum and Arsenic. These parameters may be dropped from subsequent analyses unless requested by the Department.

The Department may require tests for other parameters if site specific conditions so dictate.

Collection and preservation of water samples shall follow guidelines set down in Appendix A. Test procedures and/or minimum detectable limits for analysis of these parameters shall be in accordance with those established in Appendix A. Analytical results shall be reported on forms established by the Department (see Appendix A).

All laboratories performing water quality analyses to fulfill the requirements of section A.2.f. shall be approved by the Department.

g. Estimates will be made of projected source and amount of groundwater use during and after mining operations.

h. Water level in at least one well in each aquifer shall be continuously recorded and a hydrograph submitted to the Department.

B. Surface Water Hydrology and Quality

1. Characterization of existing environment

a. A map shall be submitted (scale 1:250,000) showing the outline of the various magnitude drainage basins of which the mine is a part. The largest basin indicated will be that tributary to the Yellowstone or Missoula River. The drainage area of each stream crossing the permit boundary should be determined for the area above and including the area to be mined.

b. Streamflow analyses shall be conducted as follows: Estimates of floods of two, five, ten, fifty, and one-hundred year recurrence shall be made using published regional data for estimation of flow in ungauged watersheds for each stream presently receiving discharge and from the streams to be physically disturbed. All calculations should be presented and the method of prediction should be cited. The Department recommends U.S.G.S. Open-File Report 75650, A Method for Esimating Magnitude

and Frequency of Floods in Montana, M. V. Johnson and R. J. Omang and/or A Suggested Procedure for Estimating Peak Flows, P. E. Farnes, Snow Survey Supervisor Soil Conservation Service, Bozeman, Montana.

c. For a distance ten miles downstream from the proposed mine, all surface water diversions and impoundments shall be shown on a map (scale 1:24,000). Data shall be submitted on quantity and type of use of this water.

d. Four longitudinal profiles of all streams leading into the permit area shall be submitted (horizontal scale 1" = 1,000 feet. Vertical exaggeration 1X and 10X). A set of profiles shall be surveyed for the stream channel and for the associated flood plain. The Department may require that a stream channel geometry study be conducted on those streams that will be affected by mining.

e. Cross-sections should be made (1) on all streams leading into the permit area at a point just upstream from the area to be mined; (2) on the same streams just downstream from the area to be mined; (2) on all streams crossing the proposed permit area at selected points to illustrate typical X-sections for similar reaches, where the channel geometry has responded to changes in gradient, bed materials, flow (effect of small dams or losing reaches over porous materials).

The Department suggests that channel cross-section surveys be made according to procedures outlined in: Emmett, W. W. and Hadley, R. F., 1968, The Vigil Network: preservation and access of data: U.S. Geological Survey Circular 460-C, 21 pp.

As outlined in this publication and in references cited by this publication, benchmarks are to be established so that cross-section can be resurveyed in following years. Channel slope at the cross-section should be determined and perennial and annual vegetation be indicated, so that discharge may be estimated using channel geometry techniques.

f. Continuous discharge measurements shall be made on at least the largest streamcourse flowing through the proposed permit area, just upstream of the permit boundary. Crest gauges shall be established on all channel courses flowing through the permit area. This data shall be submitted. The Department may require additional continuous discharge data if more than one major stream is found within the permit area.

g. Water quality analyses shall be made of all perennial streams within the permit area, on any gauged stream at the gauging site, and on any intermittent or ephemeral streams determined by the Department. Analyses may also be required for the stream presently receiving discharge from the streams to be physically disturbed by mining. Stream samples shall be taken at high flow for all types of streams. This period may result from either snow melt or rainfalls. Perennial and intermittent streams should also be sampled during warm weather low flow periods, normally in late July or August. Perennial streams should also be sampled at the low annual flow period, normally during the winter, prior to snowmelt. It will probably be necessary to remove ice to collect this sample. Minor elements shall be reported as total and dissolved. (see Appendix A)

h. Any bodies of standing water such as irrigation or stock ponds in or near the permit area which the Department determines to be significant (generally those greater than two acres in surface are) shall be sampled for water quality. Two samples shall be taken at each site, one at the highest observed water level, the other at the lowest observed water level. Complete analysis similar to stream analyses shall be done. (see Appendix A) The Department may also require bathymetric maps of pond bottoms so that sedimentation rates can be estimated.

i. If the Department determines that a nearby lake or reservoir may be impacted by a mining operation, special studies may be required to characterize that body of water.

j. The Company shall assist the Department in determining premining sediment yield and erosion rates.

2. Proposed drainage alterations

A drainage plan map (scale 1 inch = 500 feet) for the area of land to be affected shall be submitted. This plan shall indicate the direction of flow, constructed drainways, treatment facilities, natural waterways, and the streams to receive the discharge. Design specifications, drawings, method of operation and control, and quality of discharge of treatment facilities shall be submitted. Calculations shall be included and methodologies referenced including:

a. The runoff estimated for a 100-year frequency storm of six hour duration which is the minimum storm allowed in the design of any impoundment. Impoundments located where failure may cause loss of life or serious property damage shall be designed for the probably maximum precipitation event of six hour duration.

b. The design of diversion channels and the maximum flow that can be passed without erosion. A Manning equation computation should be solved to show expected velocities.

c. The textural group for the channel bottom materials.

d. An estimate of the 50 and 100 year flood using U.S.G.S. Open File Report 75-650 "A Method for Estimating Magnitude and Frequency of Floods in Montana" for ungauged watersheds.

e. Spillway design and the maximum flow that can be passed without deteriorating the dam.

II. MINING OBSERVATION

A. Groundwater Hydrology and Quality

1. Monthly, a table shall be submitted listing observation well location and water levels for each aquifer. Revised potentiometric and water table maps shall be submitted when requested.

2. Monthly, the Department shall receive estimates of daily rate of inflow into mine from affected aquifers. Any springs issuing into the mine shall be identified as to location, aquifer source, and discharge.

3. Annually, a complete water quality analysis shall be submitted for each affected aquifer, at a site or sites determined by the Department.

B. Surface Water Hydrology

1. Any surface water discharged beyond the permit boundaries is to be gauged so that a continuous record is kept. Quarterly (first day of March, June, September, December) samples shall be collected at the gauge site and complete water quality analyses completed and submitted.

2. In accordance with existing Rules and Regulations, all impoundments must be approved by the Department. Initially, the Department will require a contour map of the reservoir bottom. Periodically, the Department may require surveys of the lake bottom so that reservoir capacity and rate of sedimentation can be estimated. Annually, a complete water quality analysis of any other water bodies in or near the permit area determined by the Department shall be completed and submitted.

3. If the Department finds that mining effluent or groundwater seepage may impact a nearby lake or reservoir, continuing study of the lake or reservoir may be required by the Department.

4. Yearly surveys should be made of channel cross-sections on all streams at points where volumes of water capable of changing the channel geometry, have been discharged.

III. POST-MINING RECLAMATION

A. Groundwater Hydrology and Quality

1. Monthly, a table shall be submitted listing observation well location and water level for each aquifer requested by the Department. Revised piezometric contour maps shall be submitted when requested.

2. Annually, water quality analysis shall be completed for each aquifer at those down gradient observation wells determined by the Department. Complete analyses shall be done.

3. As backfilling and reclamation progress a groundwater monitoring system will be required to observe the zone of saturation and quality of advancing groundwaters. All plans for a monitoring network must meet Departmental approval.

B. Surface Water Hydrology and Quality

1. As drainage area increases through the life of a reclamation program and significant discharges result, continuous discharge data shall be submitted to the Department for all drainageways through the reclaimed area, measured at a point just below the permit boundary.

2. Water quality analyses shall be collected and submitted on all streams flowing through the permit area at high annual and warm season low flow periods. Any permanent impoundments permitted by the Department shall be sampled twice yearly, at high and low water stages. Complete surface water analyses shall be done.

3. As the reconstruction of stream channels progresses during reclamation, a longitudinal profile (horizontal scale 1" = 1,000 feet, vertical exaggeration 1X and 10X) shall be submitted and updated yearly or upon Departmental request in response to specific events. Cross sections on reclaimed drainages shall be established at 200 foot intervals (according to methods previously described under Preplanning).

4. Yearly, channel cross sections should be resurveyed:

   a. On all streams above and below the reestablished drainage channel.

   b. On established cross-section locations on reclaimed drainages.

5. The Company shall assist the Department in evaluating post mining sediment yield and erosion rates.

APPENDIX A

WATER QUALITY ANALYSES

(1) Upon adoption of a quality control program by the Water Quality Bureau, Department of Health and Environmental Science, all data submitted to the Department of State Lands shall be analyzed by labs certified by that Bureau. Until that time, the Department of State Lands shall submit to labs replicate, split, and spike samples as quality control checks.

(2) Sample collection.

For common constituents, sample bottles should be rinsed three times with raw water before filling. Polyethalene or glass bottles should be used, however, only glass bottles may be used to collect samples for oil and grease analysis. Field data is to be collected as required and appropriate filtration and sample preservation procedures followed. Acidification should be done with nitric acid (NHO_3), double or triple-distilled in glass. Filtration is normally done with a 0.45 pressure filter.

The following "Sample Preservation Guide" was prepared by the Water Quality Bureau, Department of Health and Environmental Sciences, and should be followed. (See last page.)

If holding times are exceeded due to extenuating circumstances, this should be noted. The Department does not expect holding times to be regularly exceeded.

(3) The following are Department approved test procedures. Other techniques that can be demonstrated to be equal or better than those listed will be accepted. Cited references are:

(1) Standard Methods for the Examination of Water and Waste Water, 13th Edition, 1971;

(2) Annual Book of ASTM Standards, Part 23, Water Atmospheric Analysis, 1972;

(3) Methods for Chemical Analysis of Water and Wastes, 1971, EPA.

Parameter and units	Method	References		
		Standard methods	ASTM	EPA methods
specific conductance (mho/cm at 25° C)	Wheatstone bridge	p. 323	p. 163	p. 284
suspended sediment, total (mg/l)	Glass fiber filtration 103-105° C	p. 537		p. 278
turbidity (Jackson units)	Turbidimeter	p. 350	p. 467	p. 308
total alkalinity as $CaCO_3$ (mg/l)	Titration; electrometric; manual or automated method--methyl orange.	p. 370	p. 143	p. 6 p. 8
total acidity (mg/l)	Electrometric end point or phenolphthalein end point.		p. 148	
oil and grease (mg/l)	Liquid-Liquid extraction with trichlorotrifluoroethane.	p. 254		
carbonate (mg/l (meg/l)	Titration; electrometric; manual or automated method --methyl orange.	p. 370	p. 143	p. 6 p. 8
bicarbonate (mg/l) (meg/l)	Titration; electromatic; manual or automated method--methyl orange.	p. 370	p. 143	p. 6 p. 8
chloride (mg/l) (meg/l)	Silver nitrate; mercuric nitrate; automated colorimetric-ferricyanide.	p. 96 p. 97	p. 23 p. 21	p. 29 p. 31
sulfate (mg/l) (meg/l)	Gravimetric; turbidimetric; automated colorimetric--barium chloranilate.	p. 331 p. 334	p. 51 p. 52	p. 286 p. 288

Parameter and units	Method	References		
		Standard	ASTM	EPA methods
calcium (mg/l) (meg/l)	EDTA titration; atomic absorption	p. 84	p. 692	p. 102
magnesium (mg/l) (meg/l)	Atomic absorption; Gravimetric	p. 210 p. 416 p. 201	p. 692	p. 112
sodium (mg/l) (meg/l)	Flame photometric; atomic absorption	p. 317	p. 326	p. 118
potassium (mg/l) (meg/l)	Atomic absorption; colorimetric; flame photometric	p. 283 p. 285	p. 326	p. 114
fluoride (mg/l) (meg/l)	Distillation--SPADNS	p. 171 p. 174	p. 191	p. 64
nitrate plus nitrite as N (total)	Automated (cadmium reduction); automated (hydrazine reduction)			p. 175 p. 185
orthophosphate as P (total)	Direct single reagent; automated single reagent or stannous chloride.	p. 432	p. 42	p. 235 p. 246

(4) The following are the toxic elements to be measured and the minimum detectable limit for each. The minimum detectable limit is defined as the concentration of an element in solution which gives a signal equal to twice the standard deviation of the series of measurements near blank level.

ELEMENT	MINIMUM DETECTABLE LIMIT (mg/l)
aluminum (al)	0.1
cadmium (Cd)	0.002
chromium (Cr)	0.02
copper (Cu)	0.01
iron (Fe)	.05
lead (Pb)	.02
manganese (Mn)	.02
mercury (Hg)	.02
selenium (se)	.005
vanadium (V)	1.0
zinc (Zn)	.01

(5) Total suspended solids, turbidity, oil and grease, and total mg/l for each toxic element need not be analyzed in ground water samples.

(6) Following is the water quality analysis summary:

PERIOD

		frequency of analysis
Preplanning:		
Aquifers	2 samples from each aquifer	every 6 months
Streams	all perennial streams (1,2,3), and those intermittent (1,2) and ephemeral (1) streams identified by the Department	1. annual high flow 2. warm season low flow 3. annual low flow
Standing Water	(identified by the Department)	annual high water level; annual low water level
Mining:		
Aquifers	affected aquifers	annually

Mining: (cont.)		
Streams	all effluent	quarterly
Standing Water	(identified by the Department)	annually
Post-Mining - Reclamation:		
Aquifers	affected aquifers	annual
Streams	all drainage through permit area	annual high flow warm season low flow
Standing Water	permanent impoundment	annual high water stage; annual low water stage

(7) Following is the format to be followed in submitting water quality reports to the Department.

Lab Analysis, page 1

Permit applicant or holder _____

County: _____

Location: Township _____ Range _____ Section _____ tract (1/4,1/4,1/4)

_____

Sample No. _____

Date Collected _____ Time collected _____

Water use _____

Sampling method _____

Sample handling: Total number of containers collected _____

Number of containers collected with preservatives added _____

Number of containers filtered _____

Number of containers collected for biological purposes _____

Flow of well, stream, effluent, etc. _____ cfs

measuring method _____

Narrative description of sample site: _____

_____

Sample source (stream, well, spring, lake, reservoir, pond, etc.) _____

Geologic source _____

Altitude of land or water surface _____

Total depth to sampling point (for wells, depth water enters well) _____

Depth of well or test hole below land surface _____

Static water level above (+) or below land surface _____

Field water temperature _____ Field pH _____

Lab Analysis, page 2

Name and location of laboratory(ies) performing analyses_____

_____

Date(s) analysis(es) completed_____

Specific conductance (mhos/cm at 25° C) _____

Suspended sediment, total (mg/l) _____

Turbidity (jtu) _____

Lab pH _____

Total alkalinity as $CaCO_3$ (mg $CaCO_{3/1}$) _____

Total acidity (if pH 7.0) (mg $CaCO_{3/1}$) _____

Sodium absorption ratio _____

Oil and grease (mg/l) _____

	dissolved mg/l	meq/l
carbonate (CO_3)		
bicarbonate (HCO_3)		
Chloride (Cl)		
Sulfate (SO_4)		
Calcium (Ca^{+})		
Magnesium (Ng)		
Sodium (Na)		
Potassium (K)		
Fluoride (F)		
Nitra ɜ (NO_3) plus nitrite as N (total)		
Orthophosphate (PO_4) as P(total)		

	total mg/l	dissolved mg/l
Aluminum (Al)		
Iron (Fe)		
Manganese (Nn)		
Cadmium (Cd)		
Copper (Cu)		
Lead (Pb)		
Zinc (Zn)		
Chromium (Cr)		
Mercury (Hg)		
Selenium (Se)		
Vanadium (V)		